SCIENCE

FRIDAY, JULY 11, 1913

CONTENTS

University Education in London: PROFESSOR F. P. MALL 33

The Optical Activity of Petroleum and its Significance: PROFESSOR W. F. BUSHONG . 39

An Ascent of the Snow Mountains of New Guinea: PROFESSOR A. C. HADDON 44

Scientific Notes and News 45

University and Educational News 47

Discussion and Correspondence:—

The Complexity of the Microorganic Population of the Soil: PROFESSOR L. H. BOLLEY. *Fowlerina Eigenmanni a preoccupied Generic Name:* HENRY W. FOWLER. *The Blowing of Soils:* ALBERT B. REAGAN. *Mosquitoes Pollinating Orchids:* C. S. CRANDALL. *Plus and Minus Again:* PROFESSOR FLORIAN CAJORI. *An Institute for Bibliographical Research:* AKSEL G. S. JOSEPHSON 48

Scientific Books:—

Recent Books on Physics: PROFESSOR G. F. HULL. *Pfeiffer's Die Steinzeitliche Technick:* DR. WALTER HOUGH. *Münsterberg's Psychology and Industrial Efficiency:* PROFESSOR H. L. HOLLINGWORTH 53

Special Articles:—

The Emission of Electrons from Tungsten at High Temperatures: PROFESSOR O. W. RICHARDSON. *Mendelian Inheritance of Epidermal Characters:* RICHARD WELLINGTON. *Powdery Scab of Potatoes in the United States:* W. J. MORSE 57

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

UNIVERSITY EDUCATION IN LONDON[1]

PROBABLY no document of greater importance to medical education, and to university education in general, has appeared in recent years than the report just issued by the Royal Commission. This commission, appointed by Edward Seventh, considered the organization and extension of the various institutions of higher education in London to constitute the new University of London. Its reports and extensive supplements have been published from time to time, and the parts which deal with medical education have been followed with interest by medical men in both Great Britain and America.

The appointment of the Royal Commission was not the beginning of the movement for reform of the educational institutions in London; it was rather the culmination of a long agitation which arose from several motives supported by different bodies and persons. It was only after the failure to secure the support of the university senate and convocation that the alternative course of applying directly to the crown for a charter establishing a new university altogether was adopted. The movement which led to this petition arose from the medical teachers who applied for a charter empowering them to confer degrees. From the point of view of university reform there was not much to be said for a proposal for substituting one examining body for another with the express

[1] Final report. T. Fisher Unwin, London, W. C. 1913. Price 2 shillings. The article was prepared as a review of the report of the commission, but in view of the importance of the subject and its interest to American men of science, it is printed as a leading article.—EDITOR.

object of providing a degree upon easier terms. Teaching and examining for degrees had long been separate functions in London, and it is clear that the Royal Commission deemed it of first importance that these functions be united in a single body, the university faculty.

Now the final report, which is a bulky volume, includes recommendations for the organization of the University of London with nine faculties. After discussing the present organization of the university, the essentials of a university in a great center of population are considered. As to the student, he should be young and should devote his entire time to his studies. A considerable amount of leisure is essential for independent reading, for common life with fellow students and teachers, and above all for the reflective thought necessary to the rather slow process of assimilation. University knowledge should be pursued not merely for the sake of information to be acquired, but for its own extension and always with reference to the attainment of truth. This alters the student's whole attitude of mind. Scientific thought becomes a habit, and almost incidentally intellectual power is developed.

The higher work of the university should be closely connected with the undergraduate work, on the one hand, and with research, on the other. Teaching and research should be combined; the university teacher should be an investigator. The greatest evil which results from the present organization of the university is that now this is not the case, and it is this which is most important to remove in the interest of higher education in London. The commission does not think it possible to get the best men as professors, if they are in any way restricted from doing their highest work, or are prevented from spreading their net wide to catch the best students. Research should not be exploited in the interest of individual capitalists, but should be a part of a great university.

The various independent schools in London, University College, King's College, technical schools, medical schools, etc., are to be blended in the new University of London, administered by various boards, so that they may give automatic rule, as is the case in Edinburgh, Oxford and Cambridge. It is a complex organization, much like that of our national government, and decidedly different from that of our American universities.

The university is to have complete control of everything relating to its work—property, organization, teaching and examinations—as is the case at Harvard, Columbia or Chicago. In its organization the constituent parts fall into faculties and departments, and there will also be schools. No institution should become a constituent college in any faculty unless it is able to provide a full course for the first and higher degrees awarded by that faculty. A university department deals with a single subject or group of studies of less range than a faculty. Its teachers would have the same standing as other university teachers of similar status, and its students would rank with students of a constituent college. Institutions which are independent but which are well equipped for the work they undertake, with a suitable staff of teachers, may become schools of the university.

In a university college or department, the teachers must be of university rank, that is, they must be actively engaged in research and in teaching. This is the key to the entire situation, and is referred to again and again in the report. The teaching should be suited for adults; it should be scientific, detached and impartial in character. It should not fill the minds of

the students with facts and theories, but it should call forth his own individuality and stimulate him to mental effort. He should become accustomed to critical study of leading authorities with occasional reference to first-hand information, and thus implant in his mind a standard of thoroughness and a sense of the value of truth. He then learns to state fairly the position of those whose conclusions he most stoutly opposes. He gains an insight into the conditions under which original research is carried on, which enables him to weigh evidence, follow and criticize argument and put his own value on authorities.

The commission then recommends the formation of faculties of arts, science, technology, economics, medicine, law, theology and music out of the existing institutions in London. Whether this is practicable is not for us to discuss, but their recommendations of necessity include a consideration of the whole university problem, and this they do in a masterful way. The tone of the report is the best, and for this reason it should be considered carefully by all American educators, especially at this time when our universities are under fire. In this review I shall confine myself to the part on medical education—and largely to the clinical side—as it has become the question of first importance in America. One fourth of the report, which is unanimously adopted by the commission, is devoted to medical education. What follows is largely verbatim.

In the case of the faculty of medicine, as in the case of other faculties, the commission considers what steps it is necessary to take in order to place the best teaching upon a real university basis. They can not, however, deal with the faculty of medicine on exactly the same lines they have followed in the case of other faculties, such as those of arts and science. In these faculties the provision for teaching of the highest university standard may be deficient, but the standard itself is not questioned.

In the case of the faculty of medicine there is no test to apply; except as regards pathology and hygiene the university has not attempted to determine which of the teachers of the subjects classed as advanced medical studies are entitled to the status of professors. The university could not do so under its existing regulations for the conferment of those titles, because none of those teachers fulfil the requirements with regard to salary, time and other conditions of employment. What is more significant, it is denied that the university ought to do so. So far as clinical teaching is concerned, another standard has been set up in the past. The university professor, according to the conception of the commission of him, can give instruction of the highest university standard only if he is actively engaged in the systematic advancement of knowledge in his subject. But in the case of medicine it is contended by many physicians that whether for university or other students the best teachers are men who are engaged in the practise of their profession, and have at most only as much time for original research as remains after the demands of their practise have been met.

The teaching of the intermediate subjects, anatomy, physiology and pharmacology, should be of the highest university standard, and should be provided in institutions closely related to the clinical departments.

The question of the reform of clinical teaching was first definitely raised before the commission in the evidence given by Mr. Abraham Flexner. They had received his report on medical education in the United States, and they had been informed

that he was preparing a similar report on medical education in Germany, France and Great Britain. This report received their careful consideration.

The fundamental principle underlying Flexner's argument is that university teaching can be given only by men who are actively and systematically engaged in the advancement of knowledge in the subject they teach. And this, of course, is a principle upon which the commission has insisted strongly in dealing with the general question of the essentials of university teaching, and the position and duties of the university professors.

But what is suggested and insisted on is that if, as is admitted, cooperation is necessary for the practise of medicine at the level of medical science to-day, it is also necessary, even in a higher degree, for the advancement of medical science beyond its present stage; further, that his cooperation does not exist in the hospital medical school, and can not do so as long as the physicians make use of science only to aid them in recognizing and curing disease, and in teaching their students to do so on the basis of existing knowledge. It is maintained that they must give their time to attacking the problems of disease, and that they can not do so alone, but must become members, and controlling and directing members of a group of men working together for a common end—a group in which the subordinate members are selected with a view to the special knowledge required to aid and supplement that of the leading and directing mind. They must devote themselves to original research under the conditions which make it productive in the case of the exceedingly complex problems which medical science has to solve. Finally it is said that the hospital unit is the kind of organization which experience has already shown provides the conditions required; and that it is only when the conditions have been found and established which make research in medical science possible and actual that the true university spirit will inform the teaching, and that the teachers will be the kind of men the commission have spoken of as university professors—men who will do for medicine what other men do for physiology and chemistry, and, indeed, for every subject which is capable of being scientifically treated. If this kind of teaching is essential, it seems to the commission clear that it can not be expected of men who are largely engaged in private practise; not only would the teaching and preparation for it make too great a demand on their time, but it is the kind of teaching which can really be successfully undertaken only by men whose main occupation is original research in the science of their subject.

Further in the opinion of the commission the University of London ought not to be satisfied with the present clinical teaching in the London medical schools. It appears to them beside the point to say, as some witnesses do, that the time for training is not the time for research, that a man has enough to learn then in order to make himself a good doctor, and that the leisure for research comes afterwards when he has taken his degree. It is not suggested that the undergraduate should engage in research in the medical faculty more than in any other, but that is no reason why he should not receive a university education. The commission has made it clear in the earlier part of the report—(*a*) that university education can be given only by university teachers, and (*b*) that it is a necessary condition of the work of university teachers that they should be systematically engaged in original work. Again, it is said that a good deal of scientific teaching is done by the present teachers,

although they are in active practise. Fortunately, there are always exceptional men who succeed in doing things which the conditions of their life and work make difficult for most; but it is necessary to consider what conditions are conducive to the end in view and likely to promote its attainments as the general rule and not as the exception. Having regard to the growing complexity of the subject of medical science, it seems to the commission that it will become more and more difficult as time goes on, for the really scientific teaching in the subject to be given by men whose powers are largely required for the arduous work of medical practise, and whose minds are quite rightly occupied for the most part with exacting claims and daily anxieties of their professional work. It is not conclusive that many eminent British physicians and surgeons have in the past made important contributions to the advancement of knowledge in this subject. It is doubted if it can fairly be claimed that the representatives of British medicine make their proper contributions to the scientific literature of the subject to-day, and although admirable work is still being done, it is all a matter of individual effort, and generally carried out under difficulties. But quite apart from this it makes all the difference in the world to the students of a university whether they have received a purely professional training or a university education in the course of which they will come into contact with the fringe of their subject, and will realize that it is a subject which is growing—that they can even play their part in making it grow.

The above summary from the report shows that the excellent and courageous studies on medical education by Flexner are being considered in Europe as well as in America.

After Flexner testified before the commission a number of eminent clinicians, including Sir William Osler and Professor Friedrich von Müller, gave their opinions on hospital organization and clinical teaching. The conditions prevailing in Munich were fully set forth by Müller, and Osler formulated an ideal plan based largely upon the German clinic. Osler's hospital unit for each of the important clinical branches comprises about sixty beds, various clinical laboratories, an out-patient department, and a director with a suitable staff. The principal teachers in clinical medicine and surgery in all the branches ought to be university professors in the same sense as the principal teachers in chemistry or physiology in a university. Under these conditions Osler thinks that we can expect the professor of medicine to carry out his three-fold duty; namely, curing the sick, studying problems of disease and teaching his students. Thus it is clear that American influences are making themselves felt in England. The recommendations of Flexner and Osler are adopted in practically every detail by the commission. To what extent the clinician should carry on private practise is quite definitely stated by the commission, conforming much more with Flexner's recommendation than with Osler's.

While it is conceded that the medical student should measure up to the university standard, it is also insisted upon that he should be taught by university clinical professors who are active in research.

Another matter to which the commission refers is the question whether, and to what extent, the professor should be prohibited by the terms of his appointment from engaging in private practise. One of the advantages of private practise is said to be that men gain in this way experience of human nature which is of great value in the

cure of the sick. It must be remembered, however, that the university professor of clinical medicine is not the less a physician because he is a man of science, and he acquires much of his knowledge in his treatment of the sick, although it may be admitted that the social range of his experience will be to some extent limited if it is confined to hospital work. The commission is inclined to think that the student whose sympathy is aroused by the condition of the hospital patient, irrespective of his social station, is the man who will work best under the conditions of private practise.

The experience of human nature, valuable though it may be, is not the only or even the chief advantage of private practise. To a limited extent, at any rate, it is said, on good authority, to be of scientific and professional value for the following reasons:

First, it trains the physician to distinguish with great accuracy between serious diseases and trifling ailments. The patients in the wards of a hospital have gone through a sifting process before admission, and the physician may generally assume that an admitted case is a case of serious illness, and his diagnosis is very much influenced by this knowledge. He may have to determine whether a patient is suffering from ulceration of the stomach, let us say, or it may be from cancer; but it does not matter much to the patient at the moment whether it is the one or the other. He is treated as seriously ill, and the treatment is such that even if the true diagnosis is not reached at once no great harm is done. But in private practise the great majority of cases that come before a doctor are cases of trifling ailments, and he is in danger of making fatal mistakes. If nine out of ten patients who complain of frequent internal pain are suffering from indigestion there is danger of failing to diagnose cancer in the tenth case, and the delay resulting from the mistake may be fatal. Experience of this risk leads to more careful observation and finer discrimination of symptoms. Secondly, it is in private practise that a physician has opportunities for the scientific observation of the earlier stages of disease. In the case of most patients admitted to the hospital the earlier stages are past, and the physician only hears the description of a case given by the patient himself, or by the general practitioner who has attended him. In both these cases, however, it is the general practitioner who acquires the kind of experience described, rather than the consulting physician, who is at present the hospital teacher. On the other hand, if the out-patient department of a general hospital is properly and seriously made use of, it affords great opportunities for acquiring this kind of knowledge and experience.

However, private practise has a tendency to make the physician consider the patient more than the disease, and for this reason it is of benefit to the teacher of medicine, and therefore he should not be prohibited from engaging in it to a certain extent. The amount of private practise would be limited by the work he had to do in the hospital together with the claims on his time by his own research if he were the right sort of a man. Of course there would be urgent cases which might be difficult to disregard. The commission meets this difficulty as follows:

One way of dealing with a call of this kind is to attend it only if the case appears to be one in which the professor is specially qualified to be of use, and then to accept no fee. This may sound a hard condition, and it would be so if externally imposed, but so powerful is the attraction of scientific work that we understand this is a self-imposed condition in the case of some ex-

isting professors. We think the conditions of a professor's employment are a matter which must be left to the university to determine; but in our opinion it is not necessary or advisable to prohibit private practise altogether.

Thus the duties of the clinical teachers in a medical school are defined. They certainly do correspond well with the opinions of some of our leading educators. Enough has been said to show the trend of the report, the full meaning of which can not be had without studying all of the pages of this excellent document. At any rate it is clear that there are far-sighted reformers on both sides of the Atlantic.

Whether or not a great hospital should conduct pay wards is not discussed. However, it is stated that in a hospital which has no end in view but medical education and the advancement of medical science, the public interest must be considered, and the question of the privilege of access to the great London hospitals can not be treated as a matter of private right or decided as if it were the private property of the existing medical schools.

FRANKLIN P. MALL

THE OPTICAL ACTIVITY OF PETROLEUM AND ITS SIGNIFICANCE[1]

THE wide distribution of deposits of bitumen, in its various forms, is attested in the very earliest writings, both sacred and profane. In the book of Genesis we learn that slime was used for mortar, and in the second book of the Maccabees we are told that

> Neemias commanded the priests to sprinkle the sacrifices with the thick water . . . and when this was done . . . there was a great fire kindled, so that every man marvelled.

Herodotus gives us the following description of the manner of its collection:

> At Ardericca is a well which produces three different substances, for asphalt, salt and oil are drawn up from it in the following manner: It is pumped up by means of a swipe, and, instead of a bucket, half a wine skin is attached to it. Having dipped down with this, a man draws it up, and then pours the contents into a reservoir, and, being poured from this into another, it assumes these different forms: the asphalt and the salt immediately become solid, but the oil they collect, and the Persians call it rhadinance. It is black and emits a strong odor.[2]

For more than 2,500 years the disciples of Zoroaster have worshiped the "eternal fires" in the neighborhood of Baku, Russia, and not until recently have their temples been replaced by oil reservoirs and refineries.

Within the last half century a new shrine has been set up in oildom, and our modern devotees have shown such zeal and activity that it may again well be said "that every man marveled." But the marvelous development of the petroleum industry has been rendered possible only by reason of the gigantic strides which have been made in the fields of natural science and technology. We may look for even greater things in the future, for science is still in its infancy. I have chosen for my subject to-night what I consider to be one of the infant industries of science.

In the year 1835 Jean Baptiste Biot published his memoir on the circular polarization of light and its application to organic chemistry,[3] which contains a table giving polarimetric data regarding essential oils. This includes a sample of "naphte" rectified by distillation, which, examined by red light gave a rotation to the left equivalent

[1] Address of the retiring president of the Kansas Academy of Science. Read December 23, 1912, at Topeka, Kansas.

[2] "Petroleum and its Products," S. F. Peckham, 1882, p. 1.

[3] *Mem. de l'Acad. de Sciences*, 13: 39, 1835. See also "Die Polarimetrie der Erdöle," M. A. Rakusin, Berlin, Wien, p. 6, 1910.

to 15.21° for a tube length of 200 mm. It is, however, very unfortunate that we have no information as to the source of this very remarkable sample.

Nearly fifty years later, in connection with their researches upon the petroleum of the Caucasus,[4] Markownikow and Ogloblin examined the natural "white naphtha" as well as some petroleum distillates, and, finding these samples inactive, they did not continue this subject any farther. In 1885, however, Demski and Morawski[5] examined some of the more important mineral oils of commerce, among which one rotated the plane of polarization 1.2° to the right. In 1898, Soltsien[6] found that the commercial paraffin oils are dextrorotatory, and that the amount of rotation increases with their specific gravity. Since that time general interest has been awakened in this subject and petroleums from all parts of the world have been examined polarimetrically. In general, it has been found that the lightest and least colored oils (including the so-called white naphthas) manifest little or no optical activity, while the heavier, dark and viscous oils yield active products.[7]

In a typical Kansas oil, examined in connection with the work of the University Geological Survey, slight optical activity was detected in the upper kerosene fraction which distilled between 250° and 300° under ordinary atmospheric pressure. The higher boiling portions of this oil after fractional distillation under diminished pressure were dextrorotatory, the amount of rotation gradually increasing with the rise in boiling point until, in the neighborhood of 280° at 27 mm., it reached almost one degree of arc.[8]

In some oils a maximum activity has been observed in the vacuum distillates collected at about 275°, and in the case of a German oil a second maximum was reached at a temperature of 310°. Javanese petroleum yields vacuum fractions boiling about 150–180° which are lævorotatory, but the higher boiling fractions are dextrorotatory.[9] A sample of petroleum from Borneo yielded a distillate collected between 260° and 340° under atmospheric pressure which was lævorotatory.[10] A lævorotatory activity has also been reported in an oil from Argentine Republic.[11]

But the fractions obtained in the distillation of petroleum do not represent distinct chemical individuals, but consist of more or less complex mixtures. Hence it is necessary for us to make use of other processes before we can isolate the optically active constituents. The fact that the distillation products of petroleum have found such a ready market without the necessity of chemically transforming them has, no doubt, greatly hindered the development of chemical methods for their utilization. But in recent years competition in the refining of illuminating oils is beginning to force the refiners to look to the utilization of their waste products. In Russian refineries the alkaline sludges are now treated so as to recover the so-called naphthenic acids which find a ready market for the manufacture of cheap soaps.

The fact that the naphthenic acids derived from kerosene show greater optical

[4] *Annales de chim. et de phys.* (6), t. II., 387, 1884.

[5] *Dingler's Polytech. Jr.*, 258: 82, 1885.

[6] *Chemisches Centralblatt*, I., 869; II., 455, 1898.

[7] Zaloziecki and Klarfeld, *Chemiker Zeitung*, 1170, 1907.

[8] Univer. Geol. Survey of Kansas, Vol. IX., p. 317, 1908.

[9] "Die neueren Ansichten über die Entstehung des Erdöls," C. Engler, Berlin, p. 55, 1907.

[10] Jones and Wootton, *Jr. Chem. Soc.*, 91: 1146, 1907.

[11] Longobardi, "Petroleum," VI., 552, 1911. *Jr. Russ. Phys.-Chem. Soc.*, 43: 792, 1911.

rotation than the kerosene was first observed by Rakusin.[12] The naphthenic acids derived from lubricating oils were found by Marcusson[13] to be much more strongly active than those derived from kerosene.

A study of isomeric naphthenic acids[14] has recently been made in the laboratory of industrial research of the University of Kansas. Commercial naphthenic acids, after being freed from hydrocarbons, were converted into esters, which were repeatedly fractionally distilled. The lowest boiling fractions were strongly lævorotatory. The succeeding fractions showed a gradual decrease until in the intermediate fractions a neutral or inactive point was reached. Above this there was a gradual increase in dextrorotatory activity. A portion of free naphthenic acids, which were similarly purified, were separately fractionated and gave results exactly parallel to those of their esters, the only difference being that the boiling points of the free acids were uniformly about 50° higher than the boiling points of their methyl esters. In other words each and every optically active constituent boiled 50° higher in the one case than in the other. This shows that these optically active constituents are acids which are esterifiable, and marks the first distinct step toward their isolation. The simplest interpretation of these facts is that the cause of the optical activity resides within the naphthenic acids themselves.

It does not necessarily follow, however, that the optically active constituents present in the commercial naphthenic acids are identical with those originally present in the petroleum. There seems to be good evidence that this is not the case, for it has been shown by Albrecht[15] that the optical activity of lubricating oils is not appreciably reduced by thorough refining by means of alkali. This result has also been confirmed by experiments with the Kansas oil distillates already mentioned, which retained most of their optical activity after being boiled with alcoholic potash. On the other hand, these experiments do not prove that no optically active acids are removed by the treatment with alkali, for it is quite possible that both lævorotatory and dextrorotatory acids may be removed in approximately equal quantities. To satisfactorily settle this question an experiment should be carried out at a refinery upon a large quantity of oil.

The naphthenic acids are generally believed to be the oxidation products of the naphthenes, or saturated cyclic hydrocarbons of the series C_nH_{2n}, which are present in most of the petroleums, but particularly in those of Russia. It is to be expected, therefore, that active acids should result from the oxidation of certain active hydrocarbons. The determination of the constitution of any of the active acids to be found in petroleum products would thus shed light upon the constitution of the active hydrocarbons from which they were formed.

The crucial test as to the correctness of our knowledge of the constitution and structure of organic compounds depends upon the methods for their synthesis. But chemical synthesis is a species of architecture, and just as the architect before beginning the erection of his structure must

[12] "Die Untersuchung des Erdöls und seiner Produkte," p. 178, 1906.

[13] *Chemiker-Zeitung*, No. 33, p. 421, 1907.

[14] Orig. Com. Eighth Internat. Cong. Appl. Chem., VI., 57–67, 1912. The same isomeric naphthenic acids have since been independently isolated, by the method of repeated fractional crystallization of their amides, by Gadaskin and Zaverschinsky, *Jr. Russ. Phys.-Chem. Soc.*, 45: 377, 1913.

[15] *Chemische Revue*, 18: 189, 1911. See also "Die Polarimetrie der Erdöle," M. A. Rakusin, p. 39.

lay down his plans and draw his designs so that each and every part shall be fitly adapted to its specific use, so the chemist must first in his imagination plan the order and arrangement of the various elements and groupings which are to be combined in such a manner as to produce the desired specific results.

The distinguishing characteristic in the structure of the optically active organic substances is that they contain at least one carbon atom which is combined with four different atoms or groups. If we consider the space distribution of the four different atoms or groups about the central carbon atom, we shall find that two arrangements are possible. The two resulting forms are related to each other in the same manner as an asymmetric object and its mirror image. Such a carbon atom is called an asymmetric carbon atom. We have for each substance containing such an asymmetric carbon atom the possibility of a right-handed structure and a left-handed structure. Corresponding to these theoretical structures we find that nature has furnished us with dextrorotatory and lævorotatory isomeric substances, which are closely identical in all of their physical and chemical properties, but differing chiefly in that the one rotates the plane of polarized light as far to the right as the other does to the left. When these two so-called stereoisomeric substances are mixed in equal quantities the resulting product is inactive. So also, when two asymmetric carbon atoms occur within the same molecule inactivity may result from internal compensation. It is thus found that among substances of asymmetric structure there are two classes which are optically inactive. The members of the one class—said to be inactive by internal compensation—are not separable into active components, while the members of the other class—said to be inactive by external compensation—are separable into dextrorotatory and lævorotatory components.

We have three methods for the separation of the optically active components, all of which are due to the researches of Pasteur.[16]

1. In some instances enantiomorphic crystals may be formed which may be mechanically separated.

2. By the aid of suitable active substances compounds may be formed which differ in their solubility, thus permitting the two optical isomers to be separated by fractional crystallization.

3. Through the action of certain microorganisms one of the optical isomers may be destroyed by fermentation while the other remains unaffected.

The direct synthesis of optically active substances from inactive material has not been effected, because both of the stereoisomeric forms are simultaneously produced by synthetic processes, but the same result is accomplished indirectly by first synthesizing the inactive mixture, or compound, and then separating the components by one of the methods already mentioned.

When, however, we find in nature substances which show optical activity we know that they must contain constituents which are asymmetric in structure. In endeavoring to determine their constitution, the chemist, therefore, gains the distinct advantage of leaving out of consideration all that vast array of substances which are symmetrically built, and of being permitted to concentrate his attention and efforts upon the relatively few possibilities of asymmetric structure.

But the chemist is not alone in the ad-

[16] "Researches on the Molecular Asymmetry of Natural Organic Products," by Louis Pasteur (1860), Alembic Club Reprint No. 14.

vantage thus gained. From what has been said regarding synthesis from inactive material it follows that all theories accounting for the formation of petroleum from inorganic material, and excluding the action of optically active organic substances, must be rejected.

But still another factor which must be considered by the geologist with reference to the origin of petroleum and other optically active bitumens is that of temperature. All theories involving violently energetic chemical reactions and the production of high temperatures must likewise be rejected.

Having thus limited the possibilities of petroleum formation, it is well to inquire what sources remain which are capable, under the conditions imposed, of supplying a sufficient amount of material for the accumulation of the vast stores which are being unearthed, and also whether the study of the polarimetric data gives promise of furnishing positive specific evidence as to the kind of material from which petroleum has been derived.

In answer to the first of these questions I quote from the report of Professor Haworth.[17]

> Few people realize the vast amount of organic matter annually carried down to the ocean by surface drainage. Vegetation covers practically the entire dry land area of the earth and has done so throughout all geologic time. Varying climatic conditions and other influences doubtless have made a corresponding variation in the richness of organic materials in different rock masses. But when all allowances are made for such variations, it remains that the amount of organic matter thus entombed is and has been enormously great. And such matter need not be confined to vegetation, for our ocean-water is teeming with animal life. Speaking broadly, it is well known that animals subsist on vegetation, and that the constant addition of food matter to the ocean-water for the ocean fauna comes from vegetation, as plants are the great agents for changing inorganic matter into organic matter. . . . If one will put himself into a position which makes it necessary to give a reasonable account for the whereabouts of all this vast quantity of organic matter, animal and vegetable, which has been engulfed in the masses of stratified rock, one will find that the quantity of oil and gas now available is all too small, rather than too large, for such accounting.

[17] The University Geological Survey of Kansas, Vol. IX., 194–195.

Even though the study of the chemical constituents of petroleum is in its infancy, attempts have already been made to detect among them specific optically active substances which may definitely and with certainty reveal their origin. The substance which has received the greatest consideration from this standpoint is cholesterin, the optically active constituent of many animal fats, or phytosterin, its vegetable equivalent. Cholesterin when distilled yields products which closely resemble the distillation products of petroleum. Furthermore, the optically active petroleum distillates usually give the same color reactions as are given by cholesterin products. Chemists are inclined, however, to view color reactions with suspicion, and demand more positive methods of proof of identity than the supporters of the cholesterin hypothesis have been able to furnish. On the other hand, the amino-acids and numerous other decomposition products of albuminous material as well as the remains of balsams, resins, terpenes, tannins, etc., must all be looked upon as contributing to the optical activity of the organic remains which may retain them. The time is ripe for the study and solution of problems of this nature.

The knowledge of the nature of the substances contained in petroleum which is to be revealed through the instrumentality of their optical properties may be put to practical use in the development of methods for extracting them and utilizing them for industrial purposes. The output of petro-

leum refineries in the past, even though enormous in quantity, has been restricted almost entirely to the extraction and clarification of products which exist ready-made in the crude oil. The various grades of gasoline and naphtha, illuminating oil, lubricating oil, paraffin, fuel oil and road oil are all marketed in a low-developed stage in the art of manufacture. The coal-tar industry, on the other hand, which utilizes a crude material closely resembling petroleum, and not a bit more inviting, has reached a high stage of development in that its products are completely transformed into an almost infinite variety of costly dye-stuffs, flavoring matters, medicinal preparations and other articles which have contributed to our wealth, our comfort and to the advance of our civilization. This utilization of what was formerly a waste product which could be disposed of only at considerable expense is a splendid example of what chemical industrial research has accomplished. The fact that petroleum products are not similarly utilized simply demonstrates that we lack the requisite knowledge.

F. W. Bushong

AN ASCENT OF THE SNOW MOUNTAINS OF NEW GUINEA

Dr. A. F. R. Wollaston has recently returned from his second expedition to Netherlands, New Guinea. Last year he published an official account of the unlucky expedition of the British Ornithological Union to the "Snow Mountains" of New Guinea. Those who have read his "Pygmies and Papuans" (London, Smith, Elder & Co., 1912) will gain some idea of the extreme difficulty of traveling in the unknown districts of that island. That expedition did not attain its main objects, but, determined not to be beaten, Dr. Wollaston has made another attempt, which has proved successful. On the present occasion Mr. C. B. Kloss, curator of the Kuala Lumpur Museum, Federated Malay States, accompanied Dr. Wollaston, and, in addition to an engineer and five native collectors, they took with them seventy-five Dyaks, and a large escort was provided by the Netherlands government. It took four and a half months to reach the mountains from the coast. The mountains, as approached from the south, are a steep escarpment of limestone rock rising abruptly from broken foothills, through which many large torrents flow in excessively steep gorges. The heavy forest of the low country extends up to between 6,000 and 7,000 feet, beyond which height it becomes less dense, and more herbaceous plants appear. Geraniums, gentians, daisies and many other palæarctic forms, besides numerous terrestrial orchids, are found in the higher regions. The limit of perpetual snow on the Ingkipulu Mountains (Nassau range) was found to be at a height of about 14,200 feet.

Unlike the Mimika River, visited by the former expedition, the Utakwa is uninhabited, probably on account of the absence of sago. The expedition was frequently visited by natives from other rivers, some of whom came from great distances. Unfortunately, they did not provide themselves with supplies for the return journey, and as the expedition proceeded on its way it encountered the dead bodies of some 30 or 40 natives, mostly women and children, whose curiosity had led them down to the low country, and who had perished from exhaustion as they were going home. The meeting with these bodies was the most terrible experience of the expedition. A hitherto unknown tribe of a rather short people of Papuan type were met with at an elevation of some 4,000–6,000 feet. Despite the very cold nights they wear no clothing. They are mainly collectors and hunters, but also grow sweet-potatoes, tobacco and sugar cane. They carry bows and arrows and shoulder bags containing apparatus for making fire, tobacco, knives, spoons and other small belongings in true Papuan style. Their knives are made of a hard, slaty stone that can be brought to so keen an edge that bamboos can be cut with them. The people are said to be extremely attractive, most friendly and in some respects

more intelligent than the people on the coast. Considerable ethnological collections were made, a few skulls of the mountain people were obtained and numerous photographs taken.

The extensive zoological collections comprise some 1,300 birds, 150 mammals, a large number of snakes and other reptiles, and several thousand insects. Among the birds is a very beautiful bird-of-paradise, which may prove to be new to science. A. C. HADDON

SCIENTIFIC NOTES AND NEWS

DR. JOHN H. FINLEY, president of the College of the City of New York, was appointed State Commissioner of Education by the State Board of Regents on July 2. Dr. Finley succeeds the late Dr. Andrew S. Draper.

NORTHWESTERN UNIVERSITY has conferred the degree of doctor of science on Dr. Robert Andrews Millikan, professor of physics in the University of Chicago.

PROFESSOR ALEXANDER GRAHAM BELL has received the honorary degree of doctor of laws from Dartmouth College in recognition of his invention of the telephone.

THE University of Michigan has conferred the honorary degree of doctor of science on Dr. Otto Klotz, astronomer of Ottawa, Canada.

THE Royal Agricultural Society of England has awarded its honorary diploma of membership to James Wilson, lately U. S. Secretary of Agriculture.

ON June 4 a number of former pupils of Professor W. E. Byerly, Perkins professor of mathematics, emeritus, at Harvard University, gave an informal dinner in his honor at the Union Club, Boston. Professor E. H. Hall was toastmaster, and the speakers were Professor Byerly, President Lowell, President Eliot, Professor Bôcher and Professor E. B. Wilson, of the Massachusetts Institute of Technology. At the close of the dinner Professor Byerly was presented with a gold watch as a gift from over 250 of his former pupils.

WE learn from *The Electrical World* that at the annual meeting of the Verein Deutsche Ingenieure, held at Leipzig, Germany, on June 23, and attended by the visiting members of the American Society of Mechanical Engineers, the Grashoff gold medal was awarded to Mr. George Westinghouse. The medal was established by the Verein in 1894 in honor of one of its founders, Frank Grashoff, who died in 1893. Each year the memorial is presented to an engineer who has rendered distinguished service to technology. Mr. Westinghouse is the first American to receive the medal. Others to whom it has been awarded are Sir Charles A. Parsons, England; Mr. Gustav de Laval, Sweden; Count Ferdinand von Zeppelin, Germany, and Mr. Aurel Stodola.

DR. C.-E. A. WINSLOW has been appointed chairman of a commission on the experimental study of ventilation problems, with an appropriation of $50,000 to be expended during the next four years. The other members of the commission are: Professor F. S. Lee, of the College of Physicians and Surgeons, Columbia University; Professor E. L. Thorndike, Teachers College, Columbia University; Professor E. B. Phelps, Massachusetts Institute of Technology; Dr. James Alexander Miller and Mr. D. D. Kimball. The fund is part of a gift made by Mrs. Elizabeth Milbank Anderson to the Association for Improving the Condition of the Poor.

M. DEBOVE, professor of clinical medicine in the University of Paris, has been elected permanent secretary of the Académie de Médicine, in the place of the late Professor Jaccoud.

DR. IRA D. CARDIFF, professor of botany in the State College of Washington, has been appointed director of the Washington Experiment Station.

DR. J. A. ALLEN, of the American Museum of Natural History, has been working at the British Museum during the past six weeks on the mammals of Korea and South America. His work is particularly complete on South American squirrels, the material which Mr. Chapman's expedition secured in Colombia and the large unidentified collections of the

British Museum providing for an entire revision of the group. The work on the Korean mammals collected by Mr. Andrews in northern Korea had the benefit of comparison with British Museum specimens secured by the Duke of Bedford's earlier expedition to Korea, the British Museum being practically the only institution in the world which contains any series of mammals from the region.

Mr. Guy West Wilson has been appointed special agent by the U. S. Bureau of Plant Industry for the study of the relation of the chestnut blight fungus to tannin and other plant products. He will be stationed at Rutgers College, New Brunswick, N. J., and work with Professor Mel. T. Cook, of that institution. He began work on July 1.

Professor A. G. Tansley, of Cambridge University, England, editor of the *New Phytologist,* will spend the greater part of the summer in America visiting botanical centers and participating in the phytogeographical excursion which is planned for the summer.

Dr. P. E. Goddard, of the American Museum of Natural History, is preparing for a trip to the upper Peace River country of northwestern Canada to make a study of the Beaver Indians, a little known tribe of the northwest; and Dr. Herbert J. Spinden will spend the summer in New Mexico on ethnological work among the Pueblo Indians of the Rio Grande Valley.

Mr. F. G. Clapp, managing geologist of the Associated Geological Engineers, sailed for Europe on June 24, for professional work in Hungary.

The Princeton University department of geology is sending a party consisting of Professor Gilbert van Ingen, in charge, Messrs. Nelson C. Dale and A. F. Buddington, fellows, and Mr. B. F. Howell, Jr., assistant in geology, to Newfoundland, to study the geology of the Conception and Trinity Bays regions. Certain problems of Cambro-Ordovician stratigraphy developed by Professor van Ingen and Mr. A. O. Hayes during their Newfoundland work in 1912, the pre-Cambrian pyroclastic and unaltered sedimentary clastic rock, and a highly interesting interbedded manganese deposit are the special problems to be studied.

The Charles Finney Cox collection of Darwiniana has been installed in a case built for it and placed in the library reading room of the New York Botanical Garden. The privilege of consulting it has already been granted to several students, and its value as a practically complete collection of the published writings of Charles Darwin will constantly increase. A bronze statuette of Charles Darwin is placed on top of the case.

Sir Archibald Geikie writes to the London *Times,* under date June 12, as follows:

Another of the vanishing literary landmarks of London is marked out for destruction. On the east side of St. Martin's-street, immediately to the south of Leicester-square, there still stands the house in which Isaac Newton spent the last 17 years of his life, and which he made the center of scientific life in this country. There he wrote and worked in the little observatory which he constructed at the top of the house. In later years the building was tenanted by Dr. Burney, author of the "History of Music," and there, unknown to him, and betaking herself to Newton's quiet garret studio, his daughter Fanny wrote her "Evelina." The house thus became as famous for its literary associations as it had been for its connection with the leaders of science. The whole property, including this house and Orange-street Chapel, belong to a trust, which is offering it for sale at the price of £30,000 for the freehold or on a building lease for 80 years at a yearly rent of £825. Newton's house occupies about a third of the site. I assume that to obtain an adequate return for the outlay of such sums would involve the demolition of the present buildings to make way for modern warehouses, offices or shops. I fear that no society or association, whether literary or scientific, nor any combination of such institutions could raise money enough to save Newton's house from destruction. But I have thought it desirable to call public attention to the matter in the faint hope that means may yet be devised to preserve so interesting a memorial of the past intellectual life of London.

We learn from *Nature* that on June 5 the faculty of science of the University of Geneva erected a bust to the memory of Pierre Prevost (1751–1839), the Geneva man of science

whose name is remembered by Prevost's theory of exchanges. Professor C. E. Guye presided at the ceremony, and most of the learned societies with which Prevost was associated sent delegates, or addresses of congratulation. M. G. Lippmann represented the Paris Academy of Sciences, and delivered an oration. The Royal Society and the Royal Society of Edinburgh were represented by Dr. W. H. Young, F.R.S., and Mr. Mitchell, respectively, who presented addresses in English. The Berlin Royal Academy of Sciences sent a letter of congratulation signed by Professor Planck.

CHARLES GREEN ROCKWOOD, professor emeritus of mathematics at Princeton University since 1905, died on July 2 at Caldwell, N. J., aged seventy-one years.

AT a meeting of the Royal Astronomical Society in London on June 13, Professor E. C. Pickering described the work being accomplished at Harvard College Observatory; Professor H. N. Russell, of Princeton University, spoke of his work in correlating the actual intrinsic brightness of the stars with their spectra, and Mr. S. S. Hough, astronomer at the Cape of Good Hope, gave details of the work being done at the Cape Observatory.

THE twentieth summer meeting and seventh colloquium of the American Mathematical Society will be held at the University of Wisconsin, Madison, Wis., during the week beginning Monday, September 8, 1913. The first two days will be devoted to the regular sessions for the presentation of papers. The colloquium will open on Wednesday morning and will close Saturday morning. Courses of lectures will be given by Professor L. E. Dickson, of the University of Chicago, on "Certain aspects of a general theory of invariants, with special consideration of modular invariants and modular geometry"; and by Professor W. F. Osgood, of Harvard University, on "Topics in the Theory of Analytic Functions of Several Complex Variables."

ARTHUR JAMES, London, has given the income of $100,000 to the Middlesex Hospital, London, in memory of his brother, William James, for the investigation of the causes of, and the search for a cure for, cancer.

NOTICE of the contest of the will of the late Henry E. Rutherford, who left a legacy of $200,000 to the Rockefeller Institute for research in cancer, has been filed.

UNIVERSITY AND EDUCATIONAL NEWS

MR. ANDREW CARNEGIE has contributed $20,000 toward the installation of the Institute of Chemistry of the University of Paris.

THE London *Times* states that in accordance with the policy of circumscribing the vast areas of affiliation of colleges to existing Indian Universities, definite steps are being taken to establish a university at or near Patna for the recently created Province of Behar and Orissa. The Lieutenant-governor in Council has appointed a committee, with Mr. R. Nathan, I.C.S., as president, to frame a scheme for the purpose. As in the case of the similar scheme for a university at Dacca for the eastern portions of Bengal and for Assam, the report will be published and circulated for opinion before action is taken on the recommendations.

DR. REID HUNT, chief of the division of pharmacology, U. S. Public Marine Service since 1904, has accepted the position of professor of pharmacology at Harvard Medical School to succeed Dr. Pfaff.

DR. J. B. WHITEHEAD, formerly professor of applied electricity in Johns Hopkins University and fellow of the American Institute of Electrical Engineers, has been appointed head of the department of electrical engineering in the new School of Technology of the university.

DR. WILFRED HAMILTON MANWARING, formerly assistant in pathology and bacteriology in the Rockefeller Institute, has been appointed professor of bacteriology and immunity at Leland Stanford Junior University, San Francisco, Cal.

THE following changes have been made in the department of chemistry at Miami University: Raymond M. Hughes, professor of chem-

istry since 1898, and acting-president since 1911, has been elected president of the university. William H. Whitcomb has been advanced from associate professor to professor and head of the department. James E. Egan, Ph.D. (Illinois, 1912), has been elected assistant professor to fill the vacancy caused by the resignation of Harvey C. Brill, Ph.D. (Michigan, 1911), to enter the government service in the Philippine Islands.

Dr. Geo. T. Hargitt, instructor in zoology at Northwestern University, has been appointed assistant professor of zoology at Syracuse University to fill the position made vacant by the transfer of Dr. Blackman to the School of Forestry.

Mr. Maurice Picard, M.A. (Columbia, '11), has been elected assistant professor of botany in Middlebury College.

At the University of Wyoming Mr. C. J. Oviatt, of the Michigan Agricultural College, becomes extension professor of agriculture and state leader in farm management and demonstration; Mr. A. E. Bowman, of the Utah Agricultural College, becomes extension professor of agriculture and assistant state leader in farm management and demonstration; research chemist, S. K. Loy, becomes professor of chemistry and research chemist; engineering chemist, Karl Steik, becomes assistant professor of chemistry and engineering chemist.

Mr. H. Clay Lint, of the Kansas Agricultural College, has accepted the industrial fellowship in plant pathology recently established in Rutgers College. He will begin work on July 15.

The General Board of Studies of Cambridge University have made the following appointments: Dr. Baker to be Cayley lecturer, and Dr. F. H. A. Marshall to be university lecturer on animal physiology, each for five years; and Mr. F. J. M. Stratton, M.A., Caius, to be university lecturer in astrophysics until March 31, 1918.

Professor Emil Abderhalden, professor of physiology in the University of Berlin, has declined the call to Vienna as the successor of Professor Ludwig.

DISCUSSION AND CORRESPONDENCE

THE COMPLEXITY OF THE MICROORGANIC POPULATION OF THE SOIL

Mr. E. J. Russell, of Rothamsted Experiment Station, has contributed a very interesting article in Science, under date of April 4, 1913.

In his opening sentence Mr. Russell says:

> During the last few years a series of experiments have been carried out in this laboratory by Dr. Hutchinson and myself which we can only interpret as showing that bacteria are not the only active inhabitants of the soil.

I write to say that I agree with this conclusion. I also agree fully with most of his statements of fact in paragraphs 1, 2, 3, 4, 5, and 6, and also with his paragraphs 7, 8, 9 and 10—in so far as they apply to the results obtained, though of course I can see no necessity of assuming that the protozoa constitute the "limiting factor" which is extinguished through partial sterilization. Mr. Russell is possibly right when he says:

> It is evident that the factor limiting bacterial numbers in ordinary soils is not bacterial, nor is it any product of bacterial activity, nor does it arise spontaneously in soils.

Though from their experiments, I see no necessity of assuming that the protozoa bring about this limitation.

In my article entitled "Interpretations of Results Noted In Experiments Upon Cereal Cropping Methods After Soil Sterilization," in Science, under date of February 10, 1912, I called attention to the thought that it might clarify matters to see what would happen in the case of "actual sterilization" of the soil.

I now call attention to the fact that in the Russell-Hutchinson experiments the sort of sterilization mentioned as being "partial" is just as liable to be effective against a large number of saprophytic fungi as it is to be effective against encysted amœboid types and that such saprophytic or semi-saprophytic fungus organisms are known to be as great reducers of organic matter, at least in its preparatory stages for bacterial activity, as some of the bacteria themselves.

If Messrs. Hutchinson and Russell are only

interested in finding out what limits the activity of the bacteria in the soil, then they and I are working upon two different problems. It would appear, however, that they wish to find out what it is that limits the bacterial activity in order that they can say that when this bacterial activity is limited there is a lessened ammonification, so that they may make the further assumption that when there is lessened ammonification there is of necessity a lessened yield of grain on the soil. In other words, they would account for the lessened or deteriorated grain product on such soils. In their regular reports in the *Journal of Agricultural Science,* they have actually made such thought transfers.

We have gone at the problem more directly in our experiments with the purpose in view of ascertaining what it is that tends to limit the grain production or to bring about deteriorated grain on fertile soils, and in doing so we have found that if we bring about rather perfect sterilization in potted soils, the limiting factor on grain production is done away with, provided we do not reintroduce it by means of internally infected seeds or other wheat disease-producing matters. Bacteria and amœbæ do not seem to play any primary part in this problem of deteriorated cereal crops.

The chemists have so thoroughly filled our minds with their belief that improvement in grain production or deterioration in grain production can only be accounted for because of modified elements of plant food that it would seem that some bacteriologists are coloring much of their work with an attempt to prove that bacteria are necessary to bring about those modifications which the chemists assume to take place.

The peculiar thing which our experiments make plain is that when we have a purified seedling placed in a purified soil, they show no element of weakness or tendency to deteriorate. Furthermore, our experiments do not show any particular necessary relationship associated with ammonification and such plant production. Deterioration takes place regardless of the presence or absence of high ammonification. We find, in ordinary soils, that a rather poor soil can produce perfect wheat seeds if free from parasitic organisms. We find also that a rich soil can not produce perfect wheat, regardless of its fertility and the amount of ammonification, if certain organisms are present in the soil or the seed.

Finally, I agree with Messrs. Russell and Hutchinson that microorganic population of the soil is "very complex," and would call their attention to the fact that in order to produce wheat on certain kinds of soil they will have to find types of amœba or other microorganism which will be capable of eating some very large fungi endways. Though we have checked up much of the work on soil toxines and gone into the bacterial proposition very carefully, especially with regard to ammonification, I yet must say that I am unable to find any cereal crop-limiting factors of any importance associated either with indefinite toxic substances or with the activity of bacteria. Having a given amount of available fertility, the plants get along. We have, however, found that there are at least one or more species each of the following mold-like fungi which, when in the soil, are real cereal crop-limiting factors: *Fusarium, Alternaria, Helminthosporium, Colletotrichum, Macrosporium* and *Ophiobolus.*

We find that most of these organisms are not only persistent in the soil, remaining there by way of the stubble and roots of their host plants, but may be introduced with the seed, fresh or improperly composted manures, etc., most of them being what may be spoken of as internal seed-infecting organisms. I would again call attention to what to me is an evident fact: that those who are working on the bacterial and toxine phases of the question of soil fertility will never have any results which they are justified in making use of until they are able to plant disease-free seedlings either in the soil or in their special cultures and to eliminate the disease factor in the soil. We have, of course, conducted many experiments, or I would not feel justified in making so strong statements as these. Were the problem of the soil fungi in wheat chopping less complex, I should long since have been giving out

much of the detail of the work at this experiment station. I will here, however, make one very interesting statement, based upon experimental results: In 1911 we had made many plantings of what we call "agar purified wheat seedlings" placing these in soil which we found to be free from the sort of organisms which we find to inhabit the average seed grain of wheat. It is not an easy matter to get an agar purified seedling—one which will grow in an agar made of synthetic media to represent the soil, or whose food basis consists of soil solution, in such manner that neither bacteria, fungi, or other organisms are found to be present in association with the roots.

When we were finally able to produce such agar-purified seedlings, they have been transplanted. In one set of such plantings in 200 lots, the average crop of wheat from such purified seedlings was 11.07 heads per seed produced on an average of 17.24 stools per seed. The heads thus grown were of rather perfect form and gave an average of 21.8 grams of nice plump wheat per plant while an untreated seedling of the same pure-bred strain of wheat, selected to the same perfect form and planted on the same day on the same soil gave an average of 6.11 heads on 8.5 stools and an average of 4.7 grams of seed.

It would make this piece of correspondence too extended to give other data of other types of seedling purification, seed treatment and soil treatment. These will not be given until published in tabular form in our regular station bulletins, but I may say that we have found that in a soil which has sufficient fertility to produce a crop, bacteria do not appear to be particularly needed so far as that individual crop is concerned, while there are certain parasitic and semi-parasitic mold-lime organisms which love the soil and the seed which are particularly detrimental and represent the chief crop-limiting factor aside from mineral elements and atmosphere.

There was a time when the bacteriologists thought they could tell safe or potable water by making counts of the number of organisms present. So now, there seem to be quite a few who think they can tell a productive soil by the number of organisms that are present therein, or by the amount of ammonification that may be or may not be taking place therein. It does not seem to be true with regard to either potatoes, flax or wheat. It made a material difference what kind of organisms were in the drinking water, so also it makes a material difference what kind of microorganisms are in the soil, and I have been unable to find that the amœbæ or their allies are particularly harmful or beneficial as associated with wheat cropping. There may, however, be some destructive fellows among them.

In making these statements, I would, of course, not be misinterpreted as assuming that bacteria do not have a useful place in the formation of plant food in the soil, nor would assume that, to a certain extent, amœboid organisms may not in part affect this development, but after a very careful reading of "Investigations on Sickness" in soil by Russell and Golding in *Journal of Agricultural Science,* Vol. V., Part 1, and the report of Messrs. Russell and Hutchinson on "The Effect of Partial Sterilization of Soil on the Production of Plant Food," as well as their original article on the same subject, October, 1909, in *Journal of Agricultural Science,* Vol. V., Part 2, I am unable to see that their experiments in any way prove a relation between amœboid activity and bacterial inactivity, nor can I see that there is any justification in the assumption that their studies in sewage-sickness show any feature characteristic of cereal sickness in arable soils. A sewage-logged soil is, at best, a poor analog of a cereal-sick arable soil. While no one can doubt that bacteria are the chief active agents in the preparation of plant foods from the rough organic remains of ordinary cropping refuse, that is one problem, and crop deterioration, as such, is another, which is superimposed upon the primary conditions of soil fertility. The crop deterioration problem is probably a problem of crop sanitation as involved in infectious disease.

H. L. Bolley
North Dakota Agricultural College,
May 15, 1913

FOWLERINA EIGENMANN A PREOCCUPIED GENERIC NAME

IN the *American Naturalist* for 1907, p. 767, Dr. Carl H. Eigenmann proposes very magnanimously the generic name *Fowlerina* for a genus of stethaprionine characins. He gives *Tetragonopterus compressus* Günther as the type.

The name, however, is antedated by *Fowlerina* Pelseneer, *Trans. Linn. Soc. London* (2), X., February, 1906, p. 149, proposed as a new genus of mollusks.

I therefore propose the generic name EPHIPPICHARAX, and give *Tetragonopterus compressus* Günther also as the type. Apparently, two species are known from the Amazons, Guiana, Paraguay and eastern Brazil. The genus is remarkable for the peculiar scale-like predorsal spine, which fits into a depression in the back. It is closely allied with *Stethaprion* Cope.

HENRY W. FOWLER
ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA,
June 12, 1913

SOME ADDITIONAL NOTES ON THE BLOWING OF SOILS

IN SCIENCE, Vol. XXVIII., pp. 653–654, I published an article on the "Blowing of Soils." I wish to add these further notes on the same subject.

It has snowed here (Nett Lake, Minn.) for practically one continuous week now and more than eighteen inches of snow has fallen in that time. The snow on the ground now is three and one half feet deep. Even the ice in the lakes is so pressed down by the additional weight of snow that the water rising on it on account thereof has stopped all lake transportation and travel. But to the subject. Yesterday with a nearly west wind, bearing a little to the north, with a velocity of probably eight miles per hour, the continuous snow that fell was so filled with dirt that it was brown. It was so conspicuous that even the Indians called my attention to the dirty snow. This dirt in the snow here was the product of a dust storm somewhere. With the snow three and one half feet deep here it must have come from the country about Medicine Hat in Canada or from the northern part of the Dakotas. From conditions here it must at least have come five hundred miles.

ALBERT B. REAGAN
NETT LAKE, MINN.,
March 20, 1913

MOSQUITOES POLLINATING ORCHIDS

IN August, 1899, seven mosquitoes bearing pollinia of the tall green orchid, *Habenaria hyperborea,* were taken at a camp on the Medicine Bow Range in northern Colorado, at an altitude of 10,200 feet. Four individuals carried two pollinia each; three carried one each. The viscid disks were attached to the lower front of the head and in some cases partially covered the eyes.

The captures were made on a rainy day within a tent located at some little distance from the stream on the banks of which the orchid grew. Examination of a considerable number of spikes showed that pollinia had been removed from many of the flowers, but actual removal by mosquitoes was not observed. Mosquitoes were extremely abundant, only a relatively small number was examined and few carried pollinia, but the impression remains that this undetermined species of mosquito may be regarded as of some importance as an agent in the pollination of this *Habenaria.*

This observation was recorded in *The Plant World,* 3: 6, January, 1900.

C. S. CRANDALL
UNIVERSITY OF ILLINOIS

PLUS AND MINUS AGAIN

DR. HALSTED'S statement[1] on the use of the symbol + in Widman's arithmetic of 1489 is apparently in conflict with my own.[2] As neither Widman's book nor the descriptions of it in the *Bibliotheca mathematica*[3] are readily accessible to most American readers, it may be well to give a fuller account. The

[1] SCIENCE, May 30, 1913, p. 837.
[2] SCIENCE, April 18, 1913, p. 610.
[3] 3. F., Bd. 9, 1908–09, pp. 155–157, 248; Bd. 10, 1909–10, pp. 182, 183.

statement that, with Widman, + meant simply "und" (and) is correct as a description of Widman's general usage. There is just one exception. Once, but only once, does Widman in his book identify + with "meer" (mehr). It is in the passage quoted by Dr. Halsted, "was auss — ist, das ist minus . . . vnnd das + das ist meer." It occurs in the explanation of a small table of weights.

Widman does not use the word "plus"; his word for addition is "vnd." As stated before, with Widman + had not yet become a purely mathematical sign. In his arithmetic (1489), as well as in a manuscript algebra in Latin, which he owned, + is used for "vnd" or "et" even in cases where "vnd" or "et" do not mean addition, as in the heading, "Regula augmenti + decrementi." It is interesting to note that he uses the word "minus" only twice in his book, and only once in the sense of —. Hence, in Widman, the words "plus" and "minus" do not occur as ordinary terms for addition and subtraction. The symbol + is often used for addition; — is used for subtraction at times, but not regularly. Apparently, the regular association of + with "plus," and — with "minus," came after Widman.

A further study of manuscripts and early printed books may throw more light upon the origin of + and — (as well as upon the first use of the decimal point), but the evidence now at hand goes against Dr. Halsted's claim that the + and —, used in the sense of $\pi = 3.14+$ and $\pi = 3.1416-$, "is historically the first meaning of the signs + and —, which arose from the marks chalked on chests of goods in German warehouses, to denote excess or defect from some standard weight." That they were so used is not denied, but the facts do not warrant the categorical statement that this "is historically the first meaning." No evidence has been adduced to establish the early use of + and — as marks chalked on chests. In the Bamberger Rechenbuch (1483) the tare to be deduced from the gross weight of a package is called "Das Minus," but the symbol — is not used. On the other hand, the regular connection of + with "vnd" in Widman's book of 1489 is unmistakable; the resemblance of + with the "et" of Latin manuscripts of the fourteenth and fifteenth centuries rests upon independent paleographic researches carried on by several writers mentioned by Cantor and Tropfke.

Florian Cajori

Colorado College

An Institute for Bibliographical Research

The writer has from time to time tried to interest librarians, bibliographers and men of science in the matter of bibliographical research and publication, or rather in organized work along these lines, in the hope that a concerted movement in its favor might be brought about—but in vain. Men of wealth have also been approached, but so far the man who would see his opportunity and endow this important work has not been found.

An effort is now being made to interest business men in the subject. Special emphasis has lately been laid on the value of an institution for the organization of bibliographical research in the interest of agriculture, manufacture and commerce. A prospectus has been sent out to a number of business men in Chicago calling attention to the value of research along these lines for both agriculture, manufacture and commerce. A "Committee on Research Institute" has been formed for the purpose of promoting the idea.

While the latest endeavor has been made along the line of business, the intention of the writer is now, as it has always been, that the only limits to the scope of the proposed institute should be the actual needs of those who might seek its assistance. The functions of the proposed research institute would be entirely practical. The institute staff would be in readiness to make researches into definite subjects at the request of those desiring special information; it would also try to anticipate the needs of inquirers and compile references on subjects of actual interest in advance of demand.

It has been estimated that a sum of $50,000, or a guaranteed income of $10,000 a year for five years, would place the institute on a basis

firm enough to promise permanency. The institute would, it is expected, soon become in part self-supporting.

The writer has often been asked what relation this proposed bibliographical institute would have to the other institutes of this kind, notably the Institut International de Bibliographie at Brussels, and the Internationales Institut für Sozialbibliographie, and allied institutions, at Berlin. The answer is that it would supplement them and, as far as possible, utilize their material. The Brussels institute collects titles of all kinds, from all sources and of all dates, the Berlin institutes collect titles from the current year on a limited number of sciences. The institute which the writer proposes would have for its object to collect titles from all sources and of all dates on a definite number of subjects, concerning which information is actually wanted.

If anybody who reads the above should be willing to assist in any way in furthering the interest of bibliographical research along the lines suggested, he should communicate with the undersigned.

AKSEL G. S. JOSEPHSON, *Chairman,*
Committee on Research Institute
THE JOHN CRERAR LIBRARY,
CHICAGO

SCIENTIFIC BOOKS

Elements of Physics. By E. H. HALL. Henry Holt & Co. Pp. 570.

A First Course in Physics. By MILLIKAN and GALE. Revised version. Ginn & Co. Pp. 430.

Applied Physics for Secondary Schools. By V. D. HAWKINS. Longmans, Green & Co. Pp. 196.

In a new text which may be looked on as a successor to Hall and Bergen's "Textbook of Physics," Professor Hall has incorporated many changes which have been suggested by discussions carried on in SCIENCE and in meetings of the American Association for the Advancement of Science. These changes are seen in the arrangement and treatment of mechanics and they tend toward the simplification of that subject. Mechanics is treated more fully in this text than in other elementary texts. The author has attempted to make the subject of the text deal with the experiences of the every-day life of the student. He has done this without introducing material and illustrations intended to make the book self-advertising, material which now figures in a number of texts. For this the text is to be commended.

The criticisms which many teachers will make are: that the text is much too full of details, that general principles do not stand out, and that the treatment is at times too didactic. How many students beginning physics are apt to understand or become enthused over this sentence on page 401, "Two conductors are said to be at the same electrical potential when the potential energy of a quantity of electricity on one is just as great as the potential energy of an equal quantity of electricity on the other, so that there is no flow of electricity from one to the other when they are connected by a conductor"? This is an unnecessarily heavy statement.

In attempting to bring in matter connected with the every-day life of the student the text has been burdened with detail. Its five hundred and seventy pages (seventy of which deal with laboratory exercises) may be regarded as encyclopedic for an elementary student.

The well-known and widely-used elementary text by Millikan and Gale has been revised, shortened by sixty pages, and improved in treatment. It is still, in its numerous details, a comprehensive text for elementary students, but it is interesting, original and up to date in subject matter. The authors aim to do away with the didactic method, yet in some of their abbreviated statements of general principles they do not accomplish this aim. To give only one example; in the deduction of the formula giving the object distance and image distance from a lens, they are content to state that a lens changes the curvature of a wave-front always by the same amount. This statement must appear an arbitrary one to a student, but had it been led up to by a

geometrical construction, as has been done by numerous teachers, it would appear more reasonable.

The two-thousand-year-old physics of Archimedes is a part of every text. That many developments in the domain of physics have been made in recent years is also generally recorded. But what physicist of ten years ago would have prophesied that the path of a helium atom could and would be photographed? And what must be the astonishment of even Mr. Wilson—whose patience and skill achieved this brilliant result—when he sees in the frontispiece of this elementary text published a few months after he did his work a reproduction of the photographs he obtained.

It is an extraordinary thing that some of the great facts of science, so difficult to obtain in the first case, are so easily understood after they have been obtained. The authors have eclipsed all others, as far as the reviewer knows, in their inclusion of new and striking developments in physics.

There is one general criticism which applies to this text and to several others. They introduce the student to the subject of physics by a study of liquids. The argument is that this study is fascinating. If that argument were to apply throughout the subject we would begin electricity with the discharge of electricity through gases, we would come to light through spectrum analyses and soap-bubble colors. The fascination which these phenomena have for students would be none the less if they were introduced in their logical place. The custom of placing the study of liquids first implies that a boy knows more about rowing or sailing a boat than he does about pulling an express-wagon or coasting on a sled; in general, that he is more at home in water or on water than on land. It may be that high-school laboratories are better equipped to show experiments setting forth the properties of liquids than experiments demonstrating motions and forces. But that does not alter the fact that force is a more elemental thing than pressure. Nor does it alter the fact that boys have a great fund of knowledge—unclassified, of course—in regard to motion and force, which knowledge can at once be made use of by a capable teacher.

It is interesting to compare the text written by Mr. Hawkins for technical high schools with the other texts arranged for general students of physics. In this text the student meets in the first chapter the difficult topics: machines, horse-power, and the Prony-brake. Later he begins the subject of electricity by the study of the dynamo. He continues this study to the performance of transformers, multiple generators, induction motors, etc. Evidently the technical high-school student must be prepared to assimilate strong food. Evidently, too, where facts of value to the commercial world are given large prominence, there is not much room for the discussion of scientific principles. For example, the experiment on the mechanical equivalent of heat is not described. Ohm's law is based on the definition of a volt! These but illustrate the criticisms which a physicist would make on the text. It does not give enough space to the presentation of the scientific method. But it does present in brief compass the main points at which physics touches commerce.

A Textbook of Physics. By Hurst and Lattey. Van Nostrand Co. In three volumes. Vol. I., Dynamics and Heat; Vol. II., Sound and Light; Vol. III., Heat, Magnetism and Electricity; a total of 640 pages.

This text is characteristic in places by its very elaborate and detailed explanations—the discussion of the passage of a beam of light through a prism takes up five pages—carried out into all the geometrical and arithmetical details. The problems are very numerous and are always identified as having been set in a certain examination. An American student may wonder why it is necessary to identify so highly original a question as this: "Describe shortly how a mercury thermometer is made. (Camb. Loc. June, '07.)" One sees that it is not the question, but the examination that is the principal thing. This text would be a very complete guide to a student going up for the army or university examinations.

Laboratory Problems in Physics. By JONES and TATNALL. Macmillan Co. Pp. 81.

Physical Laboratory Guide. By FREDERICK C. REEVES. American Book Co. Pp. 183.

A Course of Elementary Practical Physics. By H. V. S. SHORTER. Clarendon Press, Oxford. Part I., Mensuration, Mechanics, Hydrostatics. Pp. 110. Part II., Heat and Light. Pp. 216.

Jones and Tatnall's text contains outlines of about seventy-five experiments in general physics of secondary school grade. Some of the experiments are qualitative, such as are usually given in demonstrations in the classroom. Their inclusion would tend to make a laboratory course more interesting and less an exercise in following directions than most laboratory courses in physics are apt to be. The experiments are very briefly but clearly outlined and are well proportioned among the various parts of the subject. The text is named "Laboratory Problems," rather than "Laboratory Manual," probably on account of the fact that emphasis is placed upon the experimental problem, the principle or fact involved. In keeping with this idea, the outline of an exercise after giving a few brief directions (in very short sentences) consists of a series of questions tending to sharpen the student's powers of observation and reasoning. This is a most commendable feature of the text.

Mr. Reeves, an electrical engineer who is also a teacher of physics, has written a manual which places larger emphasis upon some experiments bearing upon engineering than do most manuals in physics. One evidence of this influence is seen in the fact that electricity (and magnetism) is given considerable space (from pages 23 to 59) almost at the opening of the text. Thirteen pages, an unusual amount of space, is given to Archimedes's principle with its application to the measurement of density and specific gravity. The chapter on the mechanics of *solids* opens with an experiment on the bending of beams and closes with the verification of Boyle's law!

The course which has been given by Mr. Shorter for several years at King Edward VIII. School, Sheffield, differs from that given in similar American schools in the larger space given there to mensuration. The volumes outlining the course consist of questions or directions with large blank spaces between —a cross between a series of report sheets and a laboratory manual. The spaces are rather small for the report sheets and the questions and directions rather attenuated for a manual. The heuristic method is rather overdone.

An Introduction to Mathematical Physics. By R. A. HOUSTOUN. Longmans, Green & Co. Pp. 197.

In less than two hundred pages Dr. Houstoun presents those ancient and honorable theorems in mathematical physics which English university men look upon as essential to the training of a physicist, but which look rather formidable to most students of physics in American colleges. The text starts in with the theory of attraction and potential, Gauss's theorem, Laplace's and Poisson's equations, and electrical images. It continues through hydrodynamics, Green's theorem, irrotational motion, Stokes's and Kelvin's theorems, Fourier's series with application to the conduction of heat, wave motion with application to acoustics and tidal waves, electromagnetic theory with application to the reflection and refraction of radiation, and lastly, thermodynamics with applications to reversible cells. It is a matter of wonder that a text so small can contain so much. Most physicists will feel that the experimental point of view should have had a larger place—for example, that descriptions should have been given of harmonic analyzers and synthesizers, of sound analyzers, of wave meters, and that it should have included the telegrapher's equation. The problems, too, might have been chosen with more thought of the actual and less of the geometric and ideal. But we can not have everything in two hundred pages.

DARTMOUTH COLLEGE G. F. HULL

Die Steinzeitliche Technick und Ihre Beziehungen zur Gegenwart. Ein Beitrag zur Geschichte der Arbeit von DR. LUDWIG

Pfeiffer, Geh. Med.-Rat. in Weimar, with 250 Original-Abbildungen. Jena, Verlag von Gustav Fischer. 1912.

Dr. Pfeiffer has produced an important work on the stone art in which he has not only detailed his own extensive researches on the subject, but has brought together the results found in the scattered and often inaccessible publications which have appeared from time to time. It is encouraging to workers that his enthusiasm has not been dampened by the difficulty of encompassing so vast a subject, the most part of whose materials are buried (archeological) and the rest only fragmentarily studied (ethnological culture history). If we regret that the historians of the past have not recorded for us the methods of ancient arts, so do we also mourn that there were not more of the thorough workers like Holmes, Mason, McGuire, Cushing, Roth and others, to undertake the study of present man before he lost his inherited art.

Dr. Pfeiffer remarks in his preface that organized labor goes farther back than has been supposed and that in the immensely long period before metals, man had manufactured implements and discovered processes for a definite purpose and in so doing developed industries and the tools necessary to carry them on. The work concerns the stone age up to the time of the beginning of the technical age when bronze, hard bronze and iron took the place of stone, the latter age small compared with the million years that flint dominated. He believes that the tools that have survived to us show a progressive modification as a result of their transmittal from earlier to later social units, the changes marking the phases of culture which in European archeology are practically established. The most important material covered by the monograph is naturally flint, but Dr. Pfeiffer does not lose sight of the industries connected with wood, skin and other softer materials.

The subject is so fascinating that excursions into it are almost irresistible and with some slight knowledge of the complexity of the study and the liability to error we must honor the efforts of those who are the pioneers. The problems are not simple, it is not enough to know how the American Indian made an arrowhead—there are 20 ways, or to set it on its shaft—there are many ways. A study of the mute point in a museum is good, but a study of the mind of primitive man correlated with its environment is necessary before we can loose the scientific imagination on its quest. We must manipulate the substances ourselves; we must unravel and weave again until the possibilities are exhausted so far as our limits are concerned, going again and again to the man in the hinterland of civilization and hoping, also, that some survival can be wrested from bog or cave to give us light.

The chapters are seven, as follows: (1) The History of Technic in the Stone Age, Treating of the Time Element; (2) The Physical Basis of Stone Technic; (3) The Products; (4) The Stone Age Bone Work; (5) The Stone Age Wood Work; (6) Animal Industry; (7) The Extinction of the Stone Art.

The subheadings of subjects treated under the chapters number 59 and form an interesting synopsis.

Walter Hough

Psychology and Industrial Efficiency. By Hugo Münsterberg. Boston and New York, Houghton Mifflin Company. 1913. Pp. 321. $1.50 net.

There are three varieties of books on applied psychology. To the first variety belongs the intensive monograph in which is reported some attempt to utilize the methods of experimental psychology in the detailed investigation of some limited problem of general and practical importance. This variety is represented by Thorndike's studies in the quantitative measurement of school progress. A second variety attempts directly to apply the generalizations of psychology to some particular field of daily life, and is represented by Scott's books on psychology and business. Books of the third variety are designed primarily to stimulate general interest in the possible serviceableness of the science and to suggest various directions which this service may

take at some future time. Of these three types the first is the most rare, the second the most familiar and the third the most popular. Professor Münsterberg's book belongs to the third type, and its popularity is indicated by the fact that during the month of April it was reported among the six best selling non-fiction books in the largest cities of Maryland, Massachusetts, Illinois, Michigan, Florida, Minnesota and New York, along with "The New Freedom," "The Promised Land," the Montessori books, "Zone Policeman 88" and "Auction Bridge of To-day."

The book contemplates the ultimate development of a science of "psychotechnics" which shall handle the problems of industry and economics by the application of the technique of experimental psychology. The various chapters give a series of interestingly presented illustrations of the psychotechnic point of view, the selection of examples being confined to those fields of industry which have not yet been systematically explored by applied psychology.

Tests for vocational guidance; methods of scientific management; elimination of unfit individuals from railway, ship and telephone service; economy of movement; fatigue and monotony; types of attention; the influence of weather, drugs, entertainment, rhythm, and other physical and social factors; the effectiveness of advertisements; illegal imitation; buying and selling;—all these topics, and similar ones, are discussed from the point of view of the three problems—"How to find the best possible man, how to produce the best possible work and how to secure the best possible results." Preliminary experiments are described and the work of other workers briefly summarized. The author frequently remarks that most of the experiments represent only the beginnings of investigations, which, it is hoped, will in time yield significant and useful results.

Of particular interest is the author's recognition of the importance of interests, inclinations and emotional attitudes, and of the desirability of devising tests which will measure an individual's ability to grasp a general situation. Tests of this sort will doubtless prove to be of much greater diagnostic value than the simple sensori-motor measurements. More complete data are promised in forthcoming reports of detailed investigations now being carried on in the author's laboratory. These reports will presumably belong to the rare first variety of monographs, and will be looked forward to with interest by professional psychologists to whom the present book constitutes not so much a contribution as a challenge to fulfil the prophecies of a fellow worker. Perhaps the most immediate value of the book comes from the ingenuity with which its problems are conceived and the preliminary tests devised. Professor Münsterberg's hopefulness for the future possibilities of "psychotechnics" does not keep him from placing a commendably conservative value on the actual results and correlations of his own preliminary studies.

H. L. HOLLINGWORTH
COLUMBIA UNIVERSITY

SPECIAL ARTICLES

THE EMISSION OF ELECTRONS FROM TUNGSTEN AT HIGH TEMPERATURES: AN EXPERIMENTAL PROOF THAT THE ELECTRIC CURRENT IN METALS IS CARRIED BY ELECTRONS

THAT the carriers of the negative thermionic current from incandescent solids are negative electrons was first established by J. J. Thomson.[1] In 1901[2] the writer developed the view that this emission of negative electrons occurred by virtue of the kinetic energy of thermal agitation of some of the electrons in the solid exceeding the work which was necessary to overcome the forces which tend to retain them in the body and which prevent them from escaping at lower temperatures. This conception has proved a very fruitful one and its consequences have been verified in a number of ways. It has provided a quantitative explanation of the variation of the number of electrons emitted with the temperature of the body. It led to the prediction of a cooling

[1] *Phil. Mag.*, Vol. 48, p. 547 (1899).

[2] *Camb. Phil. Proc.*, Vol. 11, p. 286 (1901); *Phil. Trans., A*, Vol. 201, p. 497 (1903).

effect when electrons are emitted by a conductor and a corresponding heating effect when they are absorbed. Both these effects[3] have since been detected experimentally and found to be of the expected magnitude, within the limits of experimental error. The magnitude and distribution of energy of the emitted electrons has been found by experiment to be that given by Maxwell's law,[4] in accordance with the requirements of the theory. Finally, the same general train of ideas has led to valuable applications in the direction of the theory of metallic conductors,[5] contact potential[6] and photoelectric action.[7]

It has long been known that ions are emitted in a number of cases in which solids react chemically with gases. The recent experiments of Haber and Just[8] indicate that the alkali metals liberate electrons when they are attacked by certain gases. It seems likely, from various considerations,[9] that effects of this nature would account for most of the emission from heated sodium which was measured by the writer.[10] In consequence of this conclusion, together with the results of a number of experiments which are at first sight in conflict with the theory referred to at the beginning of this paper,[11] the view appears to have become rather prevalent that the emission of electrons from hot bodies is invariably a secondary effect arising in some way from traces of chemical action. That this view is a mistaken one is, I think, conclusively shown by the following experiments which I have made with tungsten filaments.

The tests to be described were made with experimental tungsten lamps carrying a vertical filament of ductile tungsten which passed axially down a concentric cylindrical electrode of copper gauze or foil. The tungsten filaments were welded electrically in a hydrogen atmosphere to stout metal leads. These in turn were silver soldered to platinum wires sealed into the glass container. The lead to the copper electrode was sealed into the glass in the same way. The lamps were exhausted with a Gaede pump for several hours, during which time they were maintained at a temperature of 550–570° C. by means of a vacuum furnace. The exhaustion was then completed by means of liquid air and charcoal, the tungsten filament meanwhile being glowed out by means of an electric current at over 2200° C. Most of the tests were made after the furnace had been opened up and the walls of the lamps allowed to cool off. They were always considerably above the temperature of the room on account of the heat radiated by the glowing filament.

The processes described are extremely well adapted for getting rid of the absorbed gases and volatile impurities which form such a persistent source of difficulties in experiments of this character. Unless some such treatment is resorted to, the metal electrodes and glass walls of these tubes continue to give off relatively large amounts of gas under the influence of the heat radiated from the filaments and it has always been possible that this evolution of gas might have played an important part in the electronic emission. The mode of treatment used, for which I am largely indebted to the experience and suggestions of Dr. Irving Langmuir, of the General Electric Company's Research Laboratory at Schenectady, N. Y., seems very superior to anything in this direction which has previously been published.

Tests have been carried out covering the alternative hypotheses as to the possible mode

[3] Richardson and Cooke, *Phil. Mag.*, Vol. 20, p. 173 (1910), Vol. 21, p. 404 (1911); Cooke and Richardson, *Phil. Mag.*, Vol. 25, p. 624 (1913).

[4] Richardson and Brown, *Phil. Mag.*, Vol. 16, p. 353 (1908); Richardson, *Phil. Mag.*, Vol. 16, p. 890 (1908); Vol. 18, p. 681 (1909).

[5] Richardson, *Phil. Mag.*, Vol. 23, p. 594 (1912); Vol. 24, p. 737 (1912).

[6] Richardson, *Phil. Mag.*, Vol. 23, p. 263 (1912).

[7] Richardson, *Phil. Mag.*, Vol. 24, p. 570 (1912); Richardson and Compton, *Phil. Mag.*, Vol. 24, p. 575 (1912).

[8] *Ann. der Phys.*, Vol. 30, p. 411 (1909); Vol. 36, p. 308 (1911).

[9] Cf. Fredenhagen, *Verh. der Deutsch. Physik. Ges.*, 14 Jahrg., p. 384 (1912); Richardson, *Phil. Mag.*, Vol. 24, p. 737 (1912).

[10] *Phil. Trans., A*, Vol. 201, p. 497 (1903).

[11] Cf. Pring and Parker, *Phil. Mag.*, Vol. 23, p. 192 (1912).

of origin of the electronic emission which are enumerated below:

1. The emission is due to the evolution of gas by the filaments.

The lamp and McLeod gauge were cut off from the rest of the apparatus by means of a mercury trap, the volume being then approximately 600 c.c. A filament 4 cm. long giving a thermionic current of .064 amp. was found to increase the pressure from zero to $< 1 \times 10^{-6}$ mm. in five minutes. The number of molecules N_1 of gas given off is therefore $< 2.13 \times 10^{13}$. The number of electrons given is $N_2 = 1.2 \times 10^{20}$. The number of electrons emitted for each molecule of gas evolved is thus $N_2/N_1 > 5.64 \times 10^6$.

In the above experiment a liquid air trap was interposed to keep the mercury vapor off the filament. In another experiment with a filament 8 cm. long this was not the case and with a current of .050 amp. the pressure rose in thirty minutes to a value which was too small to measure, but which was estimated as less than 10^{-7} mm. The corresponding value of N_2/N_1 is 2.6×10^8. In this case the current was unaffected when the mercury vapor was subsequently cut off by liquid air (a change of 0.4 per cent. would have been detected).

The magnitude of the above numbers effectually disposes of the idea that the emission has anything to do with the evolution of gas.

2. The emission is caused by chemical action or some other cause depending on impacts between the gas molecules and the filaments.

In a tube with a filament 1.4 cm. in length and having 1.65×10^{-2} cm^2 superficial area the pressure rose to $< 2 \times 10^{-6}$ mm. in 5 minutes with an emission of .050 amp. If the gas is assumed to be hydrogen, which makes most impacts, using a liberally high estimate of the temperature of the copper electrode which determines the temperature of the gas, I find that the maximum number N^1 of molecules impinging per second during this interval would be $< 7.0 \times 10^{15}$. The number of electrons emitted per second would be $N_2 = 3.13 \times 10^{17}$. The ratio N_2/N^1 is thus $> 4.47 \times 10^3$. If the putative hydrogen atoms simply turned into a cloud of electrons whose total mass was equal to that of the hydrogen the value of N_2/N^1 would be only 3.68×10^3. The data already referred to for the tube with the filament 8 cm. long give an even larger ratio for N_2/N^1, namely, 1.57×10^4. Moreover, in some of our experiments the changes in gas pressure were much larger than those recorded above, but they were never accompanied by any change in the electronic emission: also the admission of mercury vapor at its pressure (about 0.001 mm.) at room temperature produces no appreciable change in the emission. Thus there is no room for the idea that the emission of electrons has anything to do with the impact of gas molecules under the conditions of these experiments.

3. The emission is a result of some process involving consumption of the tungsten.

To test this question some of the lamps were sealed off after being exhausted in the manner described. The filaments were then heated so as to give a constant thermionic current which was allowed to flow for long intervals of time. In this way the total quantity of negative electricity emitted by the filament was determined. The wire was placed in one arm of a Wheatstone's bridge so that the resistance could be recorded simultaneously. The cold resistance was also checked up from time to time.

At these high temperatures the resistance of the filaments increases slowly but continuously. This increase is believed to be due to evaporation of the tungsten. It was found to be proportional to the time of heating when the thermionic current was kept constant, in the case of any particular filament. In the case of one filament which gave 0.05 amp. for 12 hours the increase in the resistance of the hot filament was 9 per cent. The accompanying proportionate increase in the cold resistance was slightly lower, namely, 7 per cent. The latter may probably be taken as a fair measure of the amount of tungsten lost by the filament. The increase in resistance of the hot filament, which is less favorable for our case, will be considered instead

in the following experiment for which the other data are lacking.

A filament 3 cm. long gave 0.099 amp. electronic emission continuously for 2.5 hours. The resistance when hot rose from 4,773 to 4,787 in arbitrary units. The number of atoms of tungsten lost by the filament in this time was $=5.66 \times 10^{15}$, whilst the number of electrons emitted $=5.57 \times 10^{21}$. The number of electrons emitted per atom of tungsten lost was 9.84×10^{5}. The mass of the electrons emitted in this experiment was thus very close to *three times* the mass of the tungsten lost by the filament.

This tube gave 0.1 amp. electronic emission on the average for 6 hours altogether. By that time the mass of the electrons emitted was approximately 2 per cent. of the mass of the tungsten filament. The tube came to an end owing to an accident: the filament gradually became deformed until it touched the copper electrode and broke. The hardness of the tube was then tested with an induction coil and the equivalent spark gap was found to be 3.3 cm. The discharge through the tube gave a bright green fluorescence on the glass around the negative wire, but there was no indication of a glow or the faint purple haze which is obtained when traces of gas are present in tubes of this kind. There is thus no appreciable accumulation of gas even when the filaments are allowed to emit a large thermionic current continuously for a long time.

Another tube with a wire 2.7 cm. long, giving 0.050 amp., lost 1.19×10^{17} atoms of tungsten in 12 hours as measured by the change in the cold resistance. The number of electrons emitted for each atom of tungsten lost was thus 1.13×10^{5} and the mass of the emitted electrons about one third of the mass of the tungsten lost. This tube ran altogether for about 23 hours, giving various currents, and finally gave out, owing to the local loss of material near one end, caused by the sputtering or evaporation. Local over-heating is very apt to occur in these experiments as the thermionic leakage causes the heating current in the wire to be bigger at one end than the other. The mass of all the electrons emitted by this filament was equal to 4 per cent. of its total mass. Under a low-power microscope the filament did not appear to be much changed except in the region where it had burnt out, where it was much thinner than elsewhere.

There is no known reason for believing that the loss of tungsten is due to anything more profound than evaporation. But, in any event, the fact that the mass of the emitted electrons can, under favorable circumstances, exceed that of the tungsten loss proves that the loss of tungsten is not the cause of the electronic emission.

4. The only remaining process of a similar nature to those already considered which has not been discussed is the bare possibility that the emission is due to the interaction of the tungsten with some unknown condensable vapor which does not affect the McLeod gauge. This possibility is cut out by the fact that the thermionic emission is not affected when the liquid air and charcoal is cut off and the vapors allowed to accumulate in the tube, and by the fact that very considerable changes in the amount and nature of the gases present (as by the admission of mercury vapor) have no effect on the emission.

Taken together these experiments prove that the emission of electrons does not arise from any interaction between the hot filament and surrounding gases or vapors nor from any process involving consumption of the material of the filament. It thus follows that the emission of electrons from hot tungsten, which there is no reason for not regarding as exhibiting this phenomenon in a typical form, is not a chemical but a physical process. This conclusion does not exclude the possibility that, under other circumstances, electrons may be emitted from metals under the influence of various chemical reagents, a phenomenon which would be expected to exhibit the same law of dependence upon temperature; but it does involve a denial of the thesis that this emission is invariably caused by processes involving changes of material composition.

The experiments also show that the elec-

trons are not created either out of the tungsten or out of the surrounding gas. It follows that they flow into the tungsten from outside points of the circuit. The experiments therefore furnish a direct experimental proof of the electron theory of conduction in metals.

I wish to express my appreciation of the assistance I have received from Mr. K. K. Smith, instructor in the laboratory, in the preparation of the tubes and in carrying out some of the measurements. Mr. Smith and I are engaged in a more detailed quantitative study of the emission of electrons from tungsten, the results of which we hope shortly to publish. I also wish to thank Dr. W. R. Whitney and Dr. I. Langmuir, of the General Electric Company, both for supplying the specimens of ductile tungsten used and also for giving me the benefit of their invaluable experience.

O. W. RICHARDSON
PALMER PHYSICAL LABORATORY,
PRINCETON, N. J.

MENDELIAN INHERITANCE OF EPIDERMAL CHARACTERS IN THE FRUIT OF CUCUMIS SATIVUS

THE fruits of the White Spine cucumber (*Cucumis sativus*) possess numerous white epidermal spines or trichomes which roughen the skin very markedly; while those of the Richard's Invincible, an English forcing type (var. *Anglica*), possess but few, small, indistinct, early-deciduous and black spines that scarcely roughen the skin. By crossing these varieties, the White Spine having been used as the maternal parent, there was obtained a type of fruit apparently intermediate in size and in number and prominence of the spines, with the exception that all the spines were black like the paternal parent. In the F_2 generation, of the twenty plants grown fifteen bore black spines and five white spines; six possessed smooth skins with indistinct spines like the Richard's Invincible and the remainder skins with various degrees of roughness—a few even surpassing the White Spine in the number of spines. No correlation of color of spines and roughness was noted—smooth-skinned progeny possessing white as well as black spines.

The inheritance of the color of the spines apparently follows the simple Mendelian segregation, although the number of progeny is too small for a very exact interpretation; the small number of smooth-skinned types also indicates this character as a recessive one, especially as the F_1 fruits show no evidence of this character. Practically, these data are of little value unless they indicate that by crossing back one of these smooth-skinned, white-spined fruits with an English variety, it would be possible to obtain a new white-spined variety, differing in appearance but slightly from var. *Anglica;* theoretically, it adds a little more evidence to the support of Mendel's universal law.

RICHARD WELLINGTON
NEW YORK AGRICULTURAL
EXPERIMENT STATION,
GENEVA, N. Y.

POWDERY SCAB OF POTATOES IN THE UNITED STATES

IN a recent number of *Phytopathology* Professor H. T. Güssow, of Canada, Dominion Botanist, reported for the first time in America the occurrence of the well-known European "powdery" or "corky" scab of potatoes.[1] The specimens upon which he based this report were received first from Quebec, where the disease appeared to be well established in some counties. It was also recorded in isolated cases in widely separated regions of Canada, namely, Cape Breton, Nova Scotia, New Brunswick, Ontario and Alberta. These facts led Professor Güssow to suggest that probably the disease occurs in the United States.

In connection with certain studies now being carried on in the writer's laboratory upon the general subject of potato scab, requests for specimens of scabby tubers have been sent to many individuals representing widely separated localities in the state of Maine and also

[1] Güssow, H. T., "Powdery Scab of Potatoes, *Spongospora subterranea* (Wallr.) Johns.," *Phytopathology,* 3: 18–19, 1913.

to numerous friends and acquaintances in other parts of the United States. In asking for these specimens the fact was emphasized that potatoes affected by scab which differed in appearance from the ordinary type of the disease were especially desired.

As soon as received all lots of tubers were subjected to careful microscopic examination for the presence of *Rhizoctonia* and for the spore "balls" of *Spongospora subterranea* (Wallr.) Johns., or the fruiting bodies of the organism which is the cause of the powdery scab. None of the specimens showed the characteristic, superficial appearance of the last-named disease and the microscopic examination failed to establish its presence in any case beyond doubt, but practically all, regardless of the source, showed *Rhizoctonia* threads in the diseased areas. In addition poured plates were made from a large number of tubers from different sources and in every case tried the organism known as *Oospora scabies* Thaxter was isolated from some of the scabby spots.

A few of the tubers received showed small but rather pronounced pits upon their surfaces. Since these were usually more or less lined with *Rhizoctonia* threads it seemed possible that this fungus might be the primary or secondary cause of the pitting. Specimens of all lots of tubers of this kind and a considerable number of others, including samples from several different states, were planted in ten-inch pots in the greenhouse. Before planting the pots and soil were sterilized by heating for two hours under steam pressure at 20 pounds. The pots were then placed in sterilized saucers upon a raised, slat-work platform. The platform was constructed of new lumber and it and the bench upon which it rested had been previously washed with a strong solution of formaldehyde. The pots were watered with boiled water and all other precautions were taken to avoid cross infection or outside contamination.

The tubers from a part of these pots have just been harvested and in two instances rather surprising results were obtained in that in both well-developed and typical cases of powdery scab were found.[2] A careful reexamination of other tubers from the original lots of specimens, which are now badly dried out, was then made and these showed the presence of a small number of yellowish brown bodies, now considerably shrunken, but which are evidently the dried spore balls of the causal organism. One of the original lots was sent by Dr. George E. Stone from Massachusetts, while the other was received from Nebraska through the courtesy of Mr. W. A. Orton, of the Bureau of Plant Industry at Washington.

No conclusive evidence of the presence of powdery scab in other parts of the United States has been obtained, but tubers which show a few bodies in the diseased areas which somewhat resemble those upon the tubers described above have been received from one locality each in Maine, Vermont and Wisconsin. These have recently been planted in pots in the greenhouse, but it will be some time before a final decision can be made.

The fact that the disease has been obtained from such widely separated localities as Massachusetts and Nebraska would indicate that it may be quite generally distributed in the United States and suggests the possibility that it may be a factor in the cause of potato scab in this country. In order to obtain farther light on this and on the subject of potato scab in general the writer of this note wishes to obtain specimens of scabby tubers from as many different localities as possible, and will gladly pay transportation charges on any which are sent in response to this request.

W. J. Morse
Maine Agricultural Experiment Station,
May 27

[2] Mr. M. Shapovalov, to whom credit should be given for carrying out a large part of the details of the work upon which this statement is based, isolated cultures of *Oospora scabies* from the two tubers which produced the crop affected with powdery scab. He has also demonstrated that the cultures thus obtained are capable of causing, upon inoculation, the typical form of scab which is associated with the last-named organism. Hence it is evident that both forms were present on both lots of tubers.